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09/12/00
Jc921 U.S. PTO

Jc759 U.S. PTO
09/660012
09/11/00

Practitioner's Docket No. U 012948-0

PATENT

Preliminary Classification:
Proposed Class:
Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P. Section 601, 7th ed.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Optional Customer No. Bar Code

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of
Inventor(s):

1. MASAHIRO YATAKE
2. HIROTO NAKAMURA
3. HIDEHIKO KOMATSU

WARNING: 37 C.F.R. Section 1.41(a)(1) points out:

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by Section 1.63, except as provided for in Section 1.53(d)(4) and Section 1.63(d). If an oath or declaration as prescribed by Section 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to Section 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in Section 1.17(I) is filed supplying or changing the name or names of the inventor or inventors."

For (title): INK FOR THE JET RECORDING

CERTIFICATION UNDER 37 C.F.R. 1.10*

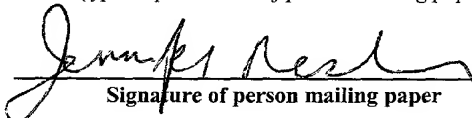
(Express Mail label number is **mandatory**.)

(Express Mail certification is optional.)

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date SEPTEMBER 12, 2000, in an envelope as "Express Mail Post Office to Addressee", mailing Label Number EL699731472US, addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

JENNIFER RASHKIN

(type or print name of person mailing paper)


Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

***WARNING:** Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).
"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

EXPRESS MAIL LABEL

NO.: EL699731472US

(New Application Transmittal--page 1 of 12) 4-1

1. Type of Application

This new application is for a(n)

(check one applicable item below)

- ☐ Original (nonprovisional)
- ☐ Design
- ☐ Plant

WARNING: *Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.*

WARNING: *Do not use this transmittal for the filing of a provisional application.*

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

- ☐ Divisional.
- ☐ Continuation.
- ☒ Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. Sections 119(e), 120, or 121)

NOTE: *A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. Section 112. Each prior application must also be:*

(I) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in Section 1.51(b); or

(iii) Entitled to a filing date as set forth in Section 1.53(b) or Section 1.53(d) and include the basic filing fee set forth in Section 1.16; or

(iv) Entitled to a filing date as set forth in Section 1.53(b) and have paid therein the processing and retention fee set forth in Section 1.21(l) within the time period set forth in Section 1.53(f).

37 C.F.R. Section 1.78(a)(1).

NOTE If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED**.

WARNING: If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-I-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

WARNING: When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application **must** be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. Section 1.78(a)(3).

- ☒ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED**.

3. Papers Enclosed

A. Required for Filing Date under 37 C.F.R. Section 1.53(b) (Regular) or 37 C.F.R. Section 1.153 (Design) Application

49 Pages of Specification
4 Pages of Claims
 Sheets of Drawing

WARNING: **DO NOT** submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to Section 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 C.F.R. 1.84, see Notice of March 9, 1988 . (1990 O.G. 57-62).

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page. . ." 37 C.F.R. Section 1.84(c)).

(complete the following, if applicable)

- ☐ The enclosed drawing(s) are in color, and there is also attached a "PETITION TO ACCEPT COLOR DRAWING(S)." 37 C.F.R. Section 1.84(b).
- ☐ Formal
- ☐ Informal

B. Other Papers Enclosed

____ Pages of declaration and power of attorney

 1 Pages of Abstract

____ Other

4. Additional Papers Enclosed

☐ Amendment to claims

☐ Cancel in this applications claims _____ before calculating the filing fee.
(At least one original independent claim must be retained for filing purposes.)

☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)

☐ Preliminary Amendment

☐ Information Disclosure Statement (37 C.F.R. Section 1.98)

☐ Form PTO-1449 (PTO/SB/08A and 08B)

☐ Citations

☐ Declaration of Biological Deposit

☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.

☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

☐ Special Comments

☐ Other

5. Declaration or Oath (including power of attorney)

NOTE: A newly executed declaration is not required in a continuation or divisional application provided the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under Section 1.47 then a copy of that declaration must be filed accompanied by a copy of the decision granting Section 1.47 status or, if a nonsigning person under Section 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. Section 1.63(d)(1)-(3).

NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name, including the family name, and at least one given name without abbreviation together with any other given name or initial, and the residence, post office address and country of citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. Section 1.63(a)(1)-(4).

NOTE: A The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by Section 1.62, except as provided for in Section 1.53(d)(4) and Section 1.63(d). If an oath or declaration as prescribed by Section 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to Section 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in Section 1.17(I) is filed supplying or changing the name or names of the inventor or inventors. 37 C.F.R. Section 1.41(a)(1).

☐ Enclosed

Executed by

(check all applicable boxes)

☐ inventor(s).

☐ legal representative of inventor(s). 37 C.F.R. Section 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 C.F.R. Section 1.47 and the statement required by 37 C.F.R. Section 1.47 is also attached. See item 13 below for fee.

☒ Not Enclosed.

NOTE: Where the filing is a completion in the U.S. of an International Application, or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☒ Application is made by a person authorized under 37 C.F.R. 1.41 on behalf of all the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 C.F.R. Section 1.16(e), can be filed subsequently).

☐ Showing that the filing is authorized.
(not required unless called into question. 37 C.F.R. Section 1.41(d))

6. Inventorship Statement

WARNING: If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of \$130.00 required by 37 C.F.R. Section 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 C.F.R. Section 1.52(d).

☒ English
☐ Non-English

☐ The attached translation includes a statement that the translation is accurate.
37 C.F.R. Section 1.52(d).

8. Assignment

☒ An assignment of the invention to SEIKO EPSON CORPORATION

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

☐ has been recorded at Reel _____, Frame _____ on _____

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment" Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: A newly executed "STATEMENT UNDER 37 C.F.R. Section 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. no.	Filed
Country	Appln. no.	Filed
Country	Appln. no.	Filed

from which priority is claimed

☐ is (are) attached.
☐ will follow.
☐ was filed in parent application _____

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 C.F.R. Section 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. **Fee Calculation** (37 C.F.R. Section 1.16)

A. ☒ Regular application

CLAIMS AS FILED						
Claims	Number Filed	Basic Fee Allowance	Number Extra	Rate	Basic Fee 37 C.F.R. Section 1.16(a) \$690.00	
Total Claims (37 C.F.R. Section 1.16(c))	21	- 20 =	1 x	\$ 18.00	18.00	
Independent Claims (37 C.F.R. Section 1.16(b))	2	- 3 =	x	\$ 78.00		
Multiple Dependent Claim(s), if any (37 C.F.R. Section 1.16(d))			+	\$260.00		

- ☐ Amendment cancelling extra claims is enclosed.
☐ Amendment deleting multiple-dependencies is enclosed.
☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 C.F.R. Section 1.16(d).

Filing Fee Calculation \$ 690.00

B. ☐ Design application
(\$310.00--37 C.F.R. Section 1.16(f))
Filing Fee Calculation \$ _____

C. ☐ Plant application
(\$480.00--37 C.F.R. Section 1.16(g))
Filing Fee Calculation \$ _____

11. Small Entity Statement(s)

- ☐ Statement(s) that this is a filing by a small entity under 37 C.F.R. Section 1.9 and 1.27 is (are) attached.

WARNING: "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under Section 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under Section 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this Section." 37 C.F.R. Section 1.28(a)(2).

WARNING: "Small entity status must not be established when the person or persons signing the . . . statement can **unequivocally** make the required self-certification." M.P.E.P. Section 509.03, 6th ed., rev. 2, July 1996 (emphasis added).

(complete the following, if applicable)

- ☐ Status as a small entity was claimed in prior application _____, filed on _____ from which benefit is being claimed for this application under:

35 U.S.C. Section	<input type="checkbox"/>	119(e) - provisional,
	<input type="checkbox"/>	120 - continuation,
	<input type="checkbox"/>	121 divisional,
	<input type="checkbox"/>	365(c) - PCT,

and which status as a small entity is still proper and desired.

- ☐ A copy of the statement in the prior application is included.

Filing Fee Calculation (50% of A, B or C above) \$ _____

NOTE: Any excess of the full fee paid will be refunded if a small entity status is established refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under Section 1.136. 37 C.F.R. Section 1.28(a).

12. Request for International-Type Search (37 C.F.R. Section 1.104(d))

(complete, if applicable)

- ☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☒ Not Enclosed

☒ No filing fee is to be paid at this time.
(This and the surcharge required by 37 C.F.R. Section 1.16(e) can be paid subsequently.)

☐ Enclosed

☐ Filing fee \$ _____

☐ Recording assignment
(\$40.00; 37 C.F.R. Section 1.21(h))
(See attached "COVER SHEET FOR
ASSIGNMENT ACCOMPANYING NEW
APPLICATION.") \$ _____

☐ Petition fee for filing by other
than all the inventors or person
on behalf of the inventor where
inventor refused to sign or cannot
be reached
(\$130.00; 37 C.F.R. Sections 1.47 and 1.17(I)) \$ _____

☐ For processing an application with a
specification in a non-English language
(\$130.00; 37 C.F.R. Sections 1.52(d) and 1.17(k)) \$ _____

☐ Processing and retention fee
(\$130.00; 37 C.F.R. Sections 1.53(d) and 1.21(l)) \$ _____

☐ Fee for international-type search report
(\$40.00; 37 C.F.R. Section 1.21(e)) \$ _____

NOTE: 37 C.F.R. Section 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 C.F.R. Section 1.53(f) and this, as well as the changes to 37 C.F.R. Section 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of Section 1.21(l) must be paid, within 1 year from notification under Section 53(f).

Total Fees Enclosed \$ _____

14. Method of Payment of Fees

- ☐ Check in the amount of \$_____.
- ☐ Charge Account No. _____ in the amount of \$_____.
A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 C.F.R. Section 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing, the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☐ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No._____.
- ☐ 37 C.F.R. Section 1.16(a), (f) or (g) (filing fees)
- ☐ 37 C.F.R. Section 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. Section 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☐ 37 C.F.R. Section 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☐ 37 C.F.R. Section 1.17(a)(1)-(5) (extension fees pursuant to Section 1.136(a).
- ☐ 37 C.F.R. Section 1.17 (application processing fees)

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under Section 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in Section 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. Section 1.136(a)(3).

- ☐ 37 C.F.R. Section 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. Section 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. Section 1.311(b)).

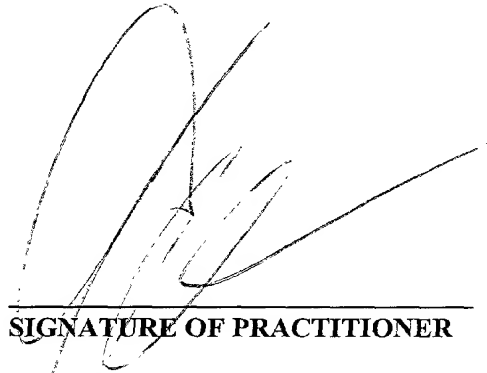
NOTE: 37 C.F.R. Section 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee." From the wording of 37 C.F.R. Section 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

NOTE: "... Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. Section 1.26(a).

☐ Credit Account No. _____.

☐ Refund



SIGNATURE OF PRACTITIONER

CLIFFORD J. MASS

(type or print name of practitioner)

✓
LADAS & PARRY

P.O. Address

26 WEST 61ST STREET

NEW YORK, NEW 10023

Reg. No. 30,086

Tel. No.: (212)708-1890

Customer No.:

[] **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☒ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added 5

[] Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

[] Plus added pages deleting names of inventor(s) named on prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added _____

[] Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

[] **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

[] This transmittal ends with this page.

[illegible]

(Added Page(s) for Special Comments for New Application Transmittal)

NOTE: See 37 CFR 1.78.

17. Relate Back

WARNING: *If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.*

(complete the following, if applicable)

[✓] Amend the specification by inserting, before the first line, the following sentence:

A. 35 U.S.C. 119(e)

NOTE: "Any nonprovisional application claiming the benefit of one or more prior filed copending provisional applications must contain or be amended to contain in the first sentence of the specification following the title a reference to each such prior provisional application, identifying it as a provisional application, and including the provisional application number (consisting of series code and serial number)." 37 C.F.R. § 1.78(a)(4).

[] "This application claims the benefit of U.S. Provisional Application(s) No(s).:

APPLICATION NO(S).:

FILING DATE

_____/

_____/

_____/

Figure 1 is a line graph showing the percentage of respondents for each age group across five categories of frequency. The y-axis represents the percentage from 0 to 100. The x-axis represents the frequency categories: (a) never, (b) once, (c) 2-3 times, (d) 4-5 times, and (e) 6 or more times. The legend indicates that the lines represent different age groups: 18-24 (solid line with circles), 25-34 (dashed line with squares), 35-44 (dotted line with triangles), 45-54 (dash-dot line with diamonds), 55-64 (solid line with crosses), and 65+ (dashed line with pluses).

Age Group	(a) never	(b) once	(c) 2-3 times	(d) 4-5 times	(e) 6 or more times
18-24	~10%	~15%	~25%	~35%	~15%
25-34	~10%	~15%	~25%	~35%	~15%
35-44	~10%	~15%	~25%	~35%	~15%
45-54	~10%	~15%	~25%	~35%	~15%
55-64	~10%	~15%	~25%	~35%	~15%
65+	~10%	~15%	~25%	~35%	~15%

and incorporates the same by reference."

B. 35 U.S.C. 120, 121 and 365(c)

NOTE: "Except for a continued prosecution application filed under § 1.53(d), any nonprovisional application claiming the benefit of one or more prior filed copending nonprovisional applications or international applications designating the United States of America must contain or be amended to contain in the first sentence of the specification following the title a reference to each such prior application, identifying it by application number (consisting of the series code and serial number) or international application number and international filing date and indicating the relationship of the applications. . . . Cross-references to other related applications may be made when appropriate." (See § 1.14(a)). 37 C.F.R. § 1.78(a)(2).

☒ "This application is a

☐ continuation

☒ continuation-in-part

☐ divisional

of copending application(s)

☒ application number 09/370,783 filed on AUGUST 5, 1999.

☐ which is

☐ International Application _____ filed on _____ and which designated the U.S.,
claims the benefit thereof and incorporates the same by reference."

NOTE: The proper reference to a prior filed PCT application that entered the U.S. national phase is the U.S. serial number and the filing date of the PCT application that designated the U.S.

NOTE: (1) Where the application being transmitted adds subject matter to the International Application, then the filing can be as a continuation-in-part or (2) if it is desired to do so for other reasons then the filing can be as a continuation.

NOTE: The deadline for entering the national phase in the U.S. for an international application was clarified in the Notice of April 28, 1987 (1079 O.G. 32 to 46) as follows:

"The Patent and Trademark Office considers the International application to be pending until the 22nd month from the priority date if the United States has been designated and no Demand for International Preliminary Examination has been filed prior to the expiration of the 19th month from the priority date and until the 32nd month from the priority date if a Demand for International Preliminary Examination which elected the United States of America has been filed prior to the expiration of the 19th month from the priority date, provided that a copy of the international application has been communicated to the Patent and Trademark Office within the 20 or 30 month period respectively. If a copy of the international application has not been communicated to the Patent and Trademark Office within the 20 or 30 month period respectively, the international application becomes abandoned as to the United States 20 or 30 months from the priority date respectively. These periods have been placed in the rules as paragraph (h) of § 1.494 and paragraph (i) of § 1.495. A continuing application under 35 U.S.C. 365(c) and 120 may be filed anytime during the pendency of the international application."

☐ "The nonprovisional application designated above, namely application _____/_____, filed _____, claims the benefit of U.S. Provisional Application(s) No(s).:

APPLICATION NO(S).:

FILING DATE

_____/_____
_____/_____
_____/_____

_____"
_____"

☐ Where more than one reference is made above please combine all references into one sentence.

18. Relate Back—35 U.S.C. 119 Priority Claim for Prior Application

The prior U.S. application(s), including any prior International Application designating the U.S., identified above in item 17B, in turn itself claim(s) foreign priority(ies) as follows:

JAPAN	1998-223479	AUGUST 6, 1998
JAPAN	1998-272094	SEPTEMBER 25, 1998
JAPAN	1998-302818	OCTOBER 23, 1998
JAPAN	1998-302819	OCTOBER 23, 1998
JAPAN	1999-67158	MARCH 12, 1999
JAPAN	1999-375316	DECEMBER 28, 1999
Country	Appln. no.	Filed

The certified copy(ies) has (have)

☒ been filed on September 15, 1999, in prior application 09/370,783, which was filed on August 15, 1999.

☐ is (are) attached.

WARNING: *The certified copy of the priority application that may have been communicated to the PTO by the International Bureau may not be relied on without any need to file a certified copy of the priority application in the continuing application. This is so because the certified copy of the priority application communicated by the International Bureau is placed in a folder and is not assigned a U.S. serial number unless the national stage is entered. Such folders are disposed of if the national stage is not entered. Therefore, such certified copies may not be available if needed later in the prosecution of a continuing application. An alternative would be to physically remove the priority documents from the folders and transfer them to the continuing application. The resources required to request transfer, retrieve the folders, make suitable record notations, transfer the certified copies, enter and make a record of such copies in the Continuing Application are substantial. Accordingly, the priority documents in folders of international applications that have not entered the national stage may not be relied on. Notice of April 28, 1987 (1079 O.G. 32 to 46).*

19. Maintenance of Copendency of Prior Application

NOTE: *The PTO finds it useful if a copy of the petition filed in the prior application extending the term for response is filed with the papers constituting the filing of the continuation application. Notice of November 5, 1985 (1060 O.G. 27).*

A. ☐ Extension of time in prior application

*(This item **must** be completed and the papers filed in the prior application, if the period set in the prior application has run.)*

☐ A petition and fee extends the term in the pending **prior** application until _____.

☐ A **copy** of the petition filed in prior application is attached.

B. ☐ Conditional Petition for Extension of Time in Prior Application

☐ A conditional petition for extension of time is being filed in the pending **prior** application.

☐ A **copy** of the conditional petition filed in the prior application is attached.

C. ☐ No extension is necessary in Prior Application

☐ Issue Fee paid _____

20. Further Inventorship Statement Where Benefit of Prior Application(s) Claimed

(complete applicable item (a), (b) and/or (c) below)

- (a) ☐ This application discloses and claims only subject matter disclosed in the prior application whose particulars are set out above and the inventor(s) in this application are

☐ the same.

- ☐ less than those named in the prior application. It is requested that the following inventor(s) identified for the prior application be deleted:

(type name(s) of inventor(s) to be deleted)

- (b) ☐ This application discloses and claims additional disclosure by amendment and a new declaration or oath is being filed. With respect to the prior application, the inventor(s) in this application are

☐ the same.

- ☐ the following additional inventor(s) have been added:

(type name(s) of inventor(s) to be deleted)

- (c) ☐ The inventorship for all the claims in this application are

☐ the same.

- ☐ not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made

☐ is submitted.

☐ will be submitted.

21. Abandonment of Prior Application *(if applicable)*

- ☐ Please abandon the prior application at a time while the prior application is pending, or when the petition for extension of time or to revive in that application is granted, and when this application is granted a filing date, so as to make this application copending with said prior application.

NOTE: According to the Notice of May 13, 1983 (103, TMOG 6-7), the filing of a continuation or continuation-in-part application is a proper response with respect to a petition for extension of time or a petition to revive and should include the express abandonment of the prior application conditioned upon the granting of the petition and the granting of a filing date to the continuing application.

22. Petition for Suspension of Prosecution for the Time Necessary to File an Amendment

WARNING: *"The claims of a new application may be finally rejected in the first Office action in those situations where (1) the new application is a continuing application of, or a substitute for, an earlier application, and (2) all the claims of the new application (a) are drawn to the same invention claimed in the earlier application, and (b) would have been properly finally rejected on the grounds of art of record in the next Office action if they had been entered in the earlier application."* MPEP, § 706.07(b).

NOTE: *Where it is possible that the claims on file will give rise to a first action final for this continuation application and for some reason an amendment cannot be filed promptly (e.g., experimental data is being gathered) it may be desirable to file a petition for suspension of prosecution for the time necessary.*

(check the next item, if applicable)

- ☐ There is provided herewith a Petition To Suspend Prosecution for the Time Necessary to File An Amendment (New Application Filed Concurrently)

23. Small Entity (37 CFR § 1.28(a))

- ☐ Applicant has established small entity status by the filing of a statement in parent application _____ on _____.

- ☐ A copy of the statement previously filed is included.

WARNING: *See 37 CFR § 1.28(a).*

24. NOTIFICATION IN PARENT APPLICATION OF THIS FILING

- ☐ A notification of the filing of this
(check one of the following)

- ☐ continuation

- ☐ continuation-in-part

- ☐ divisional

is being filed in the parent application, from which this application claims priority under 35 U.S.C. § 120.

INK FOR INK JET RECORDING

This application is a continuation-in-part application of Ser. No. 09/370,783, filed on August 5, 1999, and now abandoned.

BACKGROUND OF THE INVENTIONField of the Invention

The present invention relates to an ink for ink jet recording which can produce high-quality printed images on various recording media, and an ink jet recording method using the same.

Background Art

Ink jet recording is a method wherein an ink is ejected as droplets through fine nozzles to record letters or figures onto the surface of recording media. Ink jet recording systems which have been developed and put to practical use include: a method wherein an electric signal is converted to a mechanical signal using an electrostrictive element to intermittently eject an ink reservoir in a nozzle head section, thereby recording letters or symbols on the surface of a recording medium and a method wherein an ink, reservoir in a nozzle head section, in its portion very close to the ejection portion is rapidly heated to create a bubble and the ink is intermittently ejected by volume expansion created by the bubble to record letters or symbols on the surface of a recording medium.

Properties required of inks used in the above ink jet recording are such that the drying property of the print is good, no feathering is created in prints, good printing can be performed on various recording media, and, in the case of multi-color printing, color-to-color intermixing does not occur.

In particular, prevention of feathering is important for realizing high-quality images. Paper is likely to create feathering because it comprises fibers that are different from one another in ink penetration. In particular, this

tendency is significant for recycled paper because it comprises various fibers having different ink penetration. For this reason, in order to prevent the feathering, various proposals have been made on a reduction in penetration of the ink into recording media or an improvement in drying speed of the printed ink image.

For example, Japanese Patent Publication 2907/1990 proposes utilization of glycol ether as a wetting agent, Japanese Patent Publication 15542/1989 proposes utilization of a water-soluble organic solvent, and Japanese Patent Publication 3837/1990 proposes utilization of a glycol ether as a dye solubilizer.

Further, in order to improve the penetrability of an ink for ink jet recording, U.S. Patent No. 5,156,675 proposes addition of diethylene glycol monobutyl ether, U.S. Patent No. 5,183,502 proposes addition of Surfynol 465 (manufactured by Nissin Chemical Industry Co., Ltd.) as an acetylene glycol surfactant, and U.S. Patent No. 5,196,056 discloses addition of both diethylene glycol mono-n-butyl ether and Surfynol 465. Furthermore, U.S. Patent No. 2,083,372 studies and teaches utilization of an ether of diethylene glycol in an ink. In this connection, diethylene glycol mono-n-butyl ether is known as butylcarbitol to those skilled in the art, and detailed description thereon is given, for example, in U.S. Patent No. 3,291,580.

Regarding means for regulating the penetrability of the ink using a pigment, for example, Japanese Patent Laid-Open No. 147861/1981 discloses utilization of a pigment and triethylene glycol monomethyl ether in combination. Japanese Patent Laid-Open No. 111165/1997 discloses utilization of a pigment and an ether of ethylene glycol, diethylene glycol, or triethylene glycol in combination.

On the other hand, a method has been proposed wherein an ink is printed on a heated recording medium to rapidly evaporate the solvent component, thereby permitting the ink to be rapidly fixed onto the recording medium. Heating, however, is likely to have an adverse effect on recording

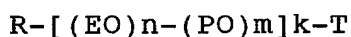
media, particularly paper. Further, this method involves an additional disadvantage of increased power consumption by heating.

5 SUMMARY OF THE INVENTION

The present inventors have now found that an ink comprising a compound having a specific structure, when used in ink jet recording, can realize good images having good drying speed and no significant feathering on various recording media, especially recycled papers.

Accordingly, it is an object of the present invention to provide an ink that can realize good images on various recording media, especially plain papers.

Thus, according to one aspect of the present invention, there is provided an ink for ink jet recording, comprising at least a water-soluble colorant, a water-soluble organic solvent, water, and a mixture of two or more compounds represented by formula (I):



20 wherein

EO represents an ethyleneoxy group;

PO represents a propyleneoxy group;

T represents an OH group or SO_3M wherein M represents a hydrogen atom, an alkali metal, an inorganic base, or an organic amine;

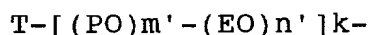
m and n are each an integer;

k is a natural number of not less than 1;

R represents

a $\text{C}_a\text{H}_{2a-k-1}$ group where a represents natural number of 4 to 10,

an $\text{Ra}-\text{C}_a\text{H}_{2a-k-2}$ group where a represents natural number of 4 to 10 and Ra represents a group represented by formula



wherein

35 EO, PO, T and k each are as defined above; and n' and m' are respectively n and m,

EO and PO being arranged, regardless of order in the

n or $n + n'$ being 1 to 10 with m or $m + m'$ being 0 to 5 when n and m and n' and m' are expressed in terms of the average value for the mixture of compounds represented by

a group represented by the following formula:

wherein K represents a saturated or unsaturated aromatic ring having 4 to 15 carbon atoms or a saturated or unsaturated aliphatic ring having 4 to 15 carbon atoms, M represents a bond or an alkylene group having 1 to 12 carbon atoms, and O represents an oxygen atom.

15 Ink for ink jet recording

Compound represented by formula (I)

In the formula (I), EO represents ethyleneoxy, that is, $-\text{CH}_2\text{CH}_2\text{O}-$, and PO represents propyleneoxy, that is, $-\text{CH}_2\text{CH}_2\text{CH}_2\text{O}-$ or $-\text{CH}(\text{CH}_3)\text{CH}_2\text{O}-$. EO and PO may be arranged in the molecule of the compound represented by formula (I) (that is, in parentheses in formula (I)) in any order and may be arranged randomly or as blocks joined together.

M in SO_3M represented by T represents a hydrogen atom, an alkali metal, an inorganic base, or an organic amine. Examples of alkali metals usable herein include lithium, sodium, and potassium. Inorganic bases usable herein include ammonia, and organic amines usable herein include mono-lower (preferably having 1 to 6 carbon atoms) alkylamines or di-lower (preferably

having 1 to 6 carbon atoms) alkylamines. Specific examples thereof include monoethanolamine, diethanolamine, triethanolamine, monoisopropanolamine, and mono-s-butanolamine.

5 The C_aH_{2a-k-1} group represented by R in formula (I) may be of branched or straight-chain type. In the group, a represents natural number of 4 to 10 and k represents the number of groups $-(EO)_n-(PO)_m-$ which attach to R. Thus, when $k=1$, R represents a C_{4-10} alkyl group and specific examples thereof include butyl, 10 pentyl, hexyl, heptyl, octyl, nonyl, and decyl groups. The alkyl group having 4 to 10 carbon atoms can provide an ink having good penetrability. As described above, the alkyl group may be of branched or straight-chain type. In general, however, the branched type is preferred. For example, in the case of a butyl 15 group, utilization of a compound with R representing a branched butyl group, that is, an isobutyl or t-butyl group, as a main component can provide an ink having good penetrability which can yield high-quality images. According to the present invention, the compound represented by formula (I) is used as a mixture.

20 In formula (I), k is a natural number of not less than 1, preferably about 1 to 4. Specifically, as described below, the compound represented by formula (I) is obtained by reacting an alcohol with ethylene oxide or propylene oxide. In this case, when an alcohol containing one OH group is used, k is 1, while 25 when a glycol containing 2 OH group, a triol having 3 OH groups, and a tetraol containing 4 OH groups are used, k values are respectively 2, 3, and 4. There is a possibility that OH groups unreacted with ethylene oxide or propylene oxide are present. According to the present invention, the compounds represented 30 by formula (I) having unreacted OH groups also fall within the scope of the present invention.

R also represents an $R_a-C_aH_{2a-k-2}$ group. The group may be of branched or straight-chain type. R_a represents a group represented by formula

35 $T-[(PO)_m'-(EO)_n']_k-$
 wherein

EO, PO, T and k each are as defined above; and n' and

m' are respectively n and m . Therefore, EO and PO may be arranged, regardless of order in the parentheses, randomly or as blocks joined together.

In formula (I), R represents group K-M-O- wherein K represents a saturated or unsaturated aromatic ring having 4 to 15 carbon atoms (preferably 4 to 10 carbon atoms) or a saturated or unsaturated aliphatic ring having 4 to 15 carbon atoms (preferably 4 to 10 carbon atoms), M represents a bond or an alkylene group having 1 to 12 carbon atoms, and O represents an oxygen atom. The aromatic ring represented by K contains at least one of nitrogen, oxygen, and sulfur atoms.

Examples of preferred cyclic compounds represented by K include a radical group derived from cycloalkane, cycloalkene, benzene, alkylbenzene, naphthalene, alkylnaphthalene, morpholine, pyridine, pyrazine, pyrimidine, pyridazine, piperazine, piperidine, dioxane, furan, thioxane, pyrroline, pyrazole, pyrazoline, pyrrolidone, pyrrolidine, imidazole, imidazolidine, imidazolidinone, lactam, and lactone rings. Furthermore, preferred examples of cyclic compounds represented by K include C₄₋₁₀ cycloalkyl, C₄₋₁₀ cycloalkenyl, phenyl, and naphthyl.

These cyclic compounds may have at least one substituent, and specific examples of substituents include straight-chain or branched alkyl groups having 1 to 6 carbon atoms, cyclic alkyl groups having 3 to 8 carbon atoms, and aryl groups, such as phenyl, tolyl, and biphenyl groups. According to a preferred embodiment of the present invention, R represents a cyclic saturated aliphatic ring having 4 to 15 carbon atoms, and specific examples thereof include cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononanyl, and cyclodecanyl. These rings may have at least one substituent, and specific examples of substituents include straight-chain or branched alkyl groups having 1 to 6 carbon atoms, cyclic alkyl groups having 3 to 8 carbon atoms, and aryl groups, such as phenyl, and tolyl

groups.

According to a preferred embodiment of the present invention, group K-M-O- has a molecular weight of not more than 200. The molecular weight of not more than 200 can realize ink compositions having a viscosity suitable for ink jet recording. When the nozzle face of the ink jet recording head has been subjected to water repellency-imparting treatment, the ink composition is less likely to wet the nozzle face and consequently can realize good printing without any ink droplet trajectory directionality problem.

According to the present invention, n and m and n' and m' are expressed in terms of average value on data for the mixture of compounds represented by formula (I) contained in the ink. n or $n + n'$ is 1 to 10, and m or $m + m'$ is 0 to 5. When n and m and n' and m' are in the above respective ranges, an ink can be obtained which is less likely to cause foaming, possesses excellent penetration, and can yield images having good quality. According to a preferred embodiment of the present invention, n and m in the mixture of compounds represented by formula (I) satisfy $n/m \geq 0.5$.

The molecular weight of the compound represented by formula (I) may be properly determined, an average molecular weight is preferably not more than 2,000, more preferably not more than 1,000, most preferably not more than 500.

According to a first preferred embodiment of the present invention, the compounds, represented by formula (I), constituting the mixture each are such that R represents a C_aH_{2a-k-1} group and T represents a hydrogen atom.

According to a second preferred embodiment of the present invention, the compounds, represented by formula (I), constituting the mixture each are such that R represents an $Ra-C_aH_{2a-k-2}$ group and T represents a hydrogen atom.

According to a third preferred embodiment of the present invention, the compounds, represented by formula (I), constituting the mixture each are such that R represents a C_aH_{2a-k-1} group and T represents SO_3M .

According to a fourth preferred embodiment of the

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formula (I) is composed of:

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(Di)Propylene glycol monobutyl ether

According to a preferred embodiment of the present invention, the ink comprises (di)propylene glycol monobutyl ether. Incorporation of (di)propylene glycol monobutyl ether can provide inks having higher penetration. The amount of (di)propylene glycol monobutyl ether added may be properly determined in such an amount range as will provide the effect of improving the penetration. The amount is, however, preferably about 0 to 10% by weight, more preferably 0.5 to 5% by weight.

According to a further preferred embodiment of the present invention, the weight ratio of the compound represented by formula (I) to the (di)propylene glycol monobutyl ether is in the range of 1 : 0 to 1 : 10.

Acetylene glycol surfactant

According to a preferred embodiment of the present invention, the ink according to the present invention contains an acetylene glycol surfactant. The addition of the acetylene glycol surfactant can provide inks which can realize images having good print quality. The amount of the acetylene glycol surfactant added may be properly determined. The amount, however, is preferably not more than about 5% by weight, more preferably about 0.1 to 2% by weight.

According to a further preferred embodiment of the present invention, the weight ratio of the compound resented by formula (I) to the acetylene glycol surfactant is in the range of 1 : 0 to 1 : 3.

Commercially available acetylene glycol surfactants may also be used, and examples thereof include Surfynol 465, TG, and 104 (manufactured by Air Products and Chemicals) and modification products thereof.

Di(tri)ethylene glycol monobutyl ether

According to a preferred embodiment of the present invention, the ink contains di(tri)ethylene glycol monobutyl ether. The addition of di(tri)ethylene glycol monobutyl ether can provide inks which can realize images having better print quality. The amount of di(tri)ethylene glycol monobutyl ether added may be properly determined. The amount,

however, is preferably not more than about 20% by weight.

According to a further preferred embodiment of the present invention, the weight ratio of the compound resented by formula (I) to di(tri)ethylene glycol monobutyl ether is in the range of 1 : 0 to 1 : 10.

Colorant

The colorant contained in the ink according to the present invention may be either a dye or a pigment.

Dyes usable herein include various dyes commonly used in ink jet recording, such as direct dyes, acid dyes, foodstuff dyes, basic dyes, reactive dyes, disperse dyes, vat dyes, soluble vat dyes, and reactive disperse dyes.

Regarding the pigment, inorganic and organic pigments are usable without any particular limitation. Examples of inorganic pigments usable herein include, in addition to titanium oxide and iron oxide, carbon blacks produced by known processes, such as contact, furnace, and thermal processes. Examples of organic pigments usable herein include azo pigments (including azo lake, insoluble azo pigment, condensed azo pigment, and chelate azo pigment), polycyclic pigments (for example, phthalocyanine, perylene, perinone, anthraquinone, quinacridone, dioxazine, thioindigo, isoindolinone, and quinophthalone pigments), dye chelates (for example, basic dye chelates and acid dye chelates), nitro pigments, nitroso pigments, and aniline black.

According to the present invention, preferred pigments are dispersible and/or soluble in water without a dispersant. These pigments are those which have been surface treated so that at least one functional group, selected from carbonyl, carboxyl, hydroxyl, and sulfone groups, or a salt thereof is bonded to the surface of the pigment, thereby permitting the pigments to be dispersible and/or soluble in water without a dispersant. Specifically, these pigments can be prepared by grafting a functional group or a molecule containing a functional group onto the surface of carbon black by physical treatment, such as vacuum plasma, or chemical treatment. In the present invention, a single type or a plurality of types

of functional groups may be grafted onto one carbon black particle. The type of the functional group to be grafted and the degree of grafting may be suitably determined by taking the dispersion stability in the ink, the color density, the drying property at the front face of the ink jet head and the like into consideration.

In the present invention, when the pigment is stably present in water without any dispersant, this state is expressed as the state of "dispersion and/or dissolution." Not infrequently, it is difficult to distinguish the state of dissolution of a material from the state of dispersion of the material. In the present invention, any pigment can be used so far as the pigment is stably present in water without any dispersant independently of whether the pigment is in a dispersion form or a solution form. In the present specification, a pigment, which can stably exist in water without any dispersant is often referred to as a "water-soluble pigment." The water-soluble pigment in this case, however, does not exclude a pigment which is in the state of dispersion in water.

According to a preferred embodiment of the present invention, the pigment is used as a pigment dispersion having an average particle diameter of 50 to 200 nm and a degree of dispersion of not more than 10.

The pigment, which is preferably used in the present invention, may be prepared, for example, by a method disclosed in Japanese Patent Laid-Open No. 3498/1996. Further, the above pigment may be a commercially available one, and preferred examples thereof include Microjet CW1 manufactured by Orient Chemical Industries, Ltd.

The amount of the pigment added to the ink is preferably 3 to 30% by weight, more preferably about 5 to 17% by weight.

Water-soluble organic solvent

Examples of the water-soluble organic solvent contained in the ink according to the present invention include: alkyl alcohols having 1 to 4 carbon atoms, such as ethanol, methanol, butanol, propanol, and isopropanol;

glycol ethers, such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, ethylene glycol monomethyl ether acetate, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, 5 diethylene glycol mono-n-propyl ether, ethylene glycol mono-iso-propyl ether, diethylene glycol mono-iso-propyl ether, ethylene glycol mono-n-butyl ether, diethylene glycol mono-n-butyl ether, triethylene glycol mono-n-butyl ether, ethylene glycol mono-t-butyl ether, diethylene glycol 10 mono-t-butyl ether, 1-methyl-1-methoxybutanol, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol mono-t-butyl ether, propylene glycol mono-n-propyl ether, propylene glycol mono-iso-propyl ether, dipropylene glycol monomethyl ether, dipropylene glycol 15 monoethyl ether, dipropylene glycol mono-n-propyl ether, dipropylene glycol mono-iso-propyl ether, propylene glycol mono-n-butyl ether, and dipropylene glycol mono-n-butyl ether; formamide; acetamide; dimethyl sulfoxide; sorbit; sorbitan; acetin; diacetin; triacetin; and sulfolane.

20 The amount of the water-soluble organic solvent added to the ink is preferably 1 to 30% by weight, more preferably about 3 to 15% by weight.

Water and other additives

25 According to the ink of the present invention, water is a main solvent. Water may be pure water obtained by ion exchange, ultrafiltration, reverse osmosis, distillation or the like, or ultrapure water. Further, water, which has been sterilized by ultraviolet irradiation or by addition of hydrogen peroxide, is suitable because, when the ink is stored 30 for a long period of time, it can prevent the growth of mold or bacteria.

35 According to a preferred embodiment of the present invention, a water-soluble glycol is added to the ink. Examples of preferred water-soluble glycols include ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, polyethylene glycol having a molecular weight of not more

than 2000, 1,3-propylene glycol, isopropylene glycol, isobutylene glycol, 1,4-butanediol, 1,3-butanediol, 1,5-pentanediol, 1,6-hexanediol, glycerin, mesoerythritol, and pentaerythritol. Water-soluble glycols function to prevent the ink from drying in the front face of nozzles.

The amount of the glycol added to the ink is preferably 1 to 30% by weight, more preferably about 3 to 15% by weight.

According to a preferred embodiment of the present invention, various saccharides may also be used in the ink. Preferred saccharides usable herein include monosaccharides and polysaccharides. More specific examples thereof include glucose, mannose, fructose, ribose, xylose, arabinose, lactose, galactose, aldonic acid, glucitose, maltose, cellobiose, sucrose, trehalose, maltotriose, alginic acid and salts thereof, cyclodextrins, and celluloses. The amount of the saccharide added to the ink is preferably about 0.05 to 30% by weight.

The addition of the saccharide can prevent a clogging phenomenon where the ink dries at the front end of the head and consequently clogs the head. In this connection, the amount of conventional saccharides, i.e., monosaccharides and polysaccharides, added to the ink is preferably about 3 to 20%. On the other hand, the amount of alginic acid and salts thereof, cyclodextrins, and celluloses added to the ink is preferably such that the low viscosity of the ink can be maintained permitting proper printing.

According to a preferred embodiment of the present invention, the ink may further comprise a surfactant. Preferred surfactants which may be added to the ink are those having good compatibility with other ingredients of the ink, and, among the surfactants, those having high penetrability and good stability are preferred. Preferred examples thereof include amphoteric surfactants and nonionic surfactants. Examples of amphoteric surfactants usable herein include lauryldimethylaminoacetic acid betaine, 2-alkyl-N-carboxymethyl-N-hydroxyethylimidazolinium betaine, coconut oil fatty acid amide

propyldimethylaminoacetic acid betaine,
polyoctylpolyaminoethylglycine, and imidazoline

derivatives. Examples of nonionic surfactants usable herein include ether surfactants, such as polyoxyethylene nonylphenyl ether, polyoxyethylene octylphenyl ether, polyoxyethylene dodecylphenyl ether, polyoxyethylene alkylallyl ether, polyoxyethylene oleyl ether, polyoxyethylene lauryl ether, polyoxyethylene alkyl ether, and polyoxyalkylene alkyl ether, polyoxyethyleneoleic acid, ester surfactants, such as polyoxyethyleneoleic ester, polyoxyethylenedistearic ester, sorbitan laurate, sorbitan monostearate, sorbitan monooleate, sorbitan sesquioleate, polyoxyethylene monooleate, and polyoxyethylene stearate, and fluorosurfactants, such as fluoroalkyl esters and salts of perfluoroalkylcarboxylic acids. It is also possible to use acethylene glycol surfactants, and examples of acethylene glycol surfactants usable herein include Surfynol 465, TG, and 104 (manufactured by Air Products and Chemicals) and modification products thereof. Addition of the surfactant permits the penetrability of the ink to be further efficiently regulated. Further, this can offer an additional advantage that the water solubility of the compounds represented by the formulae (I) can be improved.

The amount of the surfactant added to the ink is preferably 0.01 to 5% by weight, more preferably about 0.1 to 3% by weight.

According to a preferred embodiment of the present invention, when the colorant is a pigment, the ink may further comprise an emulsion. Addition of the emulsion can improve the fixation and rubbing/scratch resistance of the resultant print. Preferably, the emulsion comprises a continuous phase of water and a dispersed phase of acrylic resin, methacrylic resin, styrene resin, urethane resin, acrylamide resin, or epoxy resin or a mixture of these resins. Particularly preferred is an emulsion wherein the dispersed phase comprises a resin composed mainly of acrylic acid and/or methacrylic acid. The resin is not limited by

copolymerization methods and may be, for example, a block copolymer, a random copolymer or the like. Further, preferably, the emulsion used in the ink of the present invention has a film forming property and has a lowest possible film forming temperature of preferably room temperature or below, more preferably 0 to 20°C.

According to a preferred embodiment of the present invention, the resin component of the emulsion is a resin particle having a core/shell structure comprising a core surrounded by a shell. For example, the resin particle may be constructed so that a resin component capable of improving the drying to the touch and the fixation of the ink is incorporated into the core and a resin component, which permits resin particles to stably exist in the ink, is incorporated into the shell. According to a preferred embodiment of the present invention, the shell comprises a resin having either a crosslinked structure or a structure with the number of benzene nuclei being larger than that in the structure of the core.

Materials for the shell usable herein include styrene, tetrahydrofurfuryl acrylate and butyl methacrylate, (α , 2, 3, or 4)-alkylstyrene, (α , 2, 3, or 4)-alkoxystyrene, 3,4-dimethylstyrene, α -phenhylstyrene, divinylbenzene, vinylnaphthalene, dimethylamino (meth)acrylate, dimethylaminoethyl (meth)acrylate, dimethylaminopropylacrylamide, N,N-dimethylaminoethyl acrylate, acryloylmorpholine, N,N-dimethylacrylamide, N-isopropylacrylamide, N,N-diethylacrylamide, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, ethylhexyl (meth)acrylate, and other alkyl (meth)acrylates, methoxydiethylene glycol (meth)acrylate, (meth)acrylate of an ethyl, propyl, or butyl ester of diethylene glycol or polyethylene glycol, cyclohexyl (meth)acrylate, benzyl (meth)acrylate, phenoxyethyl (meth)acrylate, isobornyl (meth)acrylate, hydroxyalkyl (meth)acrylate, fluorine-, chlorine-, or silicon-containing (meth)acrylate, (meth)acrylamide, and maleic amide.

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The ink of the present invention may contain, in addition to the above ingredients, other ingredients. Examples of other ingredients usable herein include preservatives, antioxidants, ultraviolet absorbers, electric conductivity adjustors, pH adjustors, viscosity modifiers, surface tension modifiers, oxygen absorbers, and nozzle clogging preventives.

For example, sodium benzoate, pentachlorophenol sodium, 2-pyridinethiol-1-oxide sodium, sodium sorbate, sodium dehydroacetate, and 1,2-dibenzothiazoline-3-one (Proxel CRL, Proxel BDN, Proxel GXL, Proxel XL-2, and Proxel TN, manufactured by ICI) may be used as preservatives or antimold in the ink of the present invention.

Compounds usable as pH adjustors, solubilizers, or antioxidants in the ink include: amines, such as diethanolamine, triethanolamine, propanolamine, and morpholine, and modification products thereof; inorganic salts, such as potassium hydroxide, sodium hydroxide, and lithium hydroxide; ammonium hydroxide; quaternary ammonium hydroxide, such as tetramethylammonium; salts of carbonic acid, such as potassium carbonate, sodium carbonate, and lithium carbonate; salts of phosphoric acid, such as potassium phosphate, sodium phosphate, and lithium phosphate; N-methyl-2-pyrrolidone; urea compounds, such as urea, thiourea, and tetramethylurea; allophanate compounds, such as allophanate and methyl allophanate; biuret compounds, such as biuret, dimethylbiuret, and tetramethylbiuret; and L-ascorbic acid and salts thereof.

Examples of antioxidants and ultraviolet absorbers include Tinuvin 328, 900, 1130, 384, 292, 123, 144, 622, 770, and 292, Irgacor 252 and 153, and Irganox 1010, 1076, 1035, and MD1024, manufactured by Ciba-Geigy, and lanthanide oxides.

Viscosity modifiers usable herein include rosin compounds, alginic acid compounds, polyvinyl alcohol, hydroxypropyl cellulose, carboxymethyl cellulose, hydroxyethyl cellulose, methyl cellulose, salts of

polyacrylic acid, polyvinyl pyrrolidone, gum arabic, and starch.

Ink jet recording method and apparatus

5 The ink jet recording method used with the ink according to the present invention refers to a recording method wherein a droplet of an ink is ejected and deposited onto a recording medium to perform printing. Examples of such ink jet recording methods include, for example, a method wherein an electric signal is converted to a mechanical signal using
10 an electrostrictive element to intermittently eject an ink reservoir in a nozzle head section, thereby recording letters or symbols on the surface of a recording medium, and a method wherein an ink, reservoir in a nozzle head section, in its portion very close to the ejection portion is rapidly
15 heated to create a bubble and the ink is intermittently ejected by volume expansion created by the bubble to record letters or symbols on the surface of a recording medium. According to a preferred embodiment of the present invention, the ink of the present invention is used in ink jet recording
20 using an electrostrictive element. This is because methods involving heating of the head section are likely to cause the colorant and other ingredients contained in the ink to be decomposed, clogging the head.

25 An ink, which may contain a pigment as the colorant, having a relatively high content of a solid, like the ink of the present invention, when placed in a nozzle without ejection for a long period of time, is likely to dry at the front face of the nozzle to cause thickening, leading to an ink droplet trajectory directionality problem. In this case,
30 slightly moving the ink with care not to cause the ink to be delivered from the front face of the nozzle can stir the ink, permitting the ink to be stably ejected. This can be achieved by pressurizing the ink, by means of pressurizing means for ejecting the ink, with care not to cause the ink
35 to be ejected. In the above regulation, use of an electrostrictive element as the pressurizing means is preferred from the viewpoint of easy regulation.

Utilization of this mechanism can increase the content of the pigment in the ink, permitting a high color density to be provided using a pigment-based ink and, in addition, the ink to be stably ejected.

5 When the above slight moving of the ink is carried out in the nozzle face of an ink jet recording apparatus, this operation is effective for an ink having a pigment content of about 5 to 15% by weight, more preferably about 7 to 10% by weight.

10 In use, the ink of the present invention may be filled into an ink tank constructed so that a polyurethane foam is provided therein and the ink comes into contact with the polyurethane foam. In this case, the glycol ether compound, which is preferably used in the present invention, and the
15 acetylene glycol surfactant used in the present invention are adsorbed onto the polyurethane foam. Therefore, preferably, they are added in an excessive amount in consideration of the adsorption. Further, the polyurethane foam can ensure a negative pressure by using the ink of the
20 present invention and is less likely to be decomposed by ingredients of the ink used in the present invention, or to create a deposit causative of clogging of the nozzle. A polyurethane foam not using a curing catalyst containing a metal salt or a cationic material is preferred. Specifically,
25 use of a polyurethane foam comprising a polyfunctional isocyanate, such as tolylene diisocyanate or *m*-xylene diisocyanate, and a material having a plurality of hydroxyl groups, such as a glycol compound having an average molecular weight of about 300 to 3000, such as polypropylene glycol
30 or polyethylene glycol, glycerin, pentaerythritol, dipentaerythritol, neopentyl glycol, propylene glycol, 1,3-butanediol, 1,4-butanediol, or 1,5-pentanediol, is preferred from the viewpoint of ensuring negative pressure, by virtue of the stability of foam shape, and chemical
35 stability.

 When the acetylene glycol surfactant is utilized, a part of the acetylene glycol surfactant is adsorbed onto the

polyurethane foam. Therefore, when the acetylene glycol surfactant is added to the ink, the composition of the ink should be determined by taking into consideration the amount of the acetylene glycol surfactant adsorbed onto the urethane foam.

According to a preferred embodiment of the present invention, the ink of the present invention is printed by ejecting a droplet of the ink through a nozzle the front end (head) of which has a water-repellent surface. More specifically, the front end of the nozzle preferably has a structure produced by providing a stainless steel material as a base material, applying a eutectoid plating of tetrafluoroethylene and nickel on the base, and heat-treating the plating to form a water-repellent layer. In addition, utilization of a eutectoid plating of tetrafluoroethylene and a highly non-oxidizable metal, such as chromium, titanium, gold, platinum, silver, or iridium, instead of nickel is also preferred. A combination of the ink according to the present invention with the above nozzle enables continuous printing to be stably performed for a long period of time.

According to a more preferred embodiment of the present invention, the contact angle of the ink on the water-repellent surface at the front end of the nozzle is 50 degrees or above at a general operation temperature of the printer (for example, 15 to 60°C). According to this embodiment, improved print quality and continuous printing can be realized.

EXAMPLES

The present invention will be described in more detail with reference to the following examples, though it is not limited to these examples only.

In the following description, the following abbreviations are used.

DEGmBE: diethylene glycol mono-n-butyl ether
DMI: 1,3-dimethyl-2-imidazolidinone
PGmBE: propylene glycol mono-n-butyl ether
MPD: 2-methyl-2,4-pentanediol

to the system with stirring in a nitrogen atmosphere at 70°C. A monomer solution was prepared by adding 0.05 part of sodium laurylsulfate, 10 parts of styrene, 10 parts of butyl methacrylate, and 0.02 part of t-dodecylmercaptan to 7 parts
5 of ion-exchanged water. This monomer solution was added dropwise to the reactor at 70°C to perform a reaction. Thus a primary compound was prepared. A 10% ammonium persulfate solution (2 parts) was added to the primary compound. The mixture was stirred. A reaction solution composed of 30
10 parts of ion-exchanged water, 0.2 part of potassium laurylsulfate, 35 parts of styrene, 25 parts of butyl methacrylate, 10 parts of acrylic acid, 1 part of bisphenol A dimethacrylate, and 0.5 part of t-dodecylmercaptan was added to the mixture at 70°C with stirring to perform a
15 polymerization reaction. Thereafter, the system was neutralized with ammonia and adjusted to pH 8 to 8.5, followed by filtration through a 0.3 μ m filter to obtain polymeric fine particle B as an emulsion.

Polymeric fine particle C

20 Ion-exchanged water (100 parts) was placed in a reactor equipped with a dropping device, a thermometer, a water cooling type reflux condenser, and a stirrer. Potassium persulfate as a polymerization initiator (0.2 part) was added to the system with stirring in a nitrogen atmosphere at 70°C.
25 A monomer solution was prepared by adding 0.05 part of sodium laurylsulfate, 15 parts of styrene, 6 parts of benzyl methacrylate, 10 parts of butyl methacrylate, and 0.02 part of t-dodecylmercaptan to 7 parts of ion-exchanged water. This monomer solution was added dropwise to the reactor at
30 70°C to perform a reaction. Thus a primary compound was prepared. A 10% ammonium persulfate solution (2 parts) was added to the primary compound. The mixture was stirred. A reaction solution composed of 30 parts of ion-exchanged water, 0.2 part of potassium laurylsulfate, 30 parts of styrene,
35 15 parts of butyl methacrylate, 10 parts of acrylic acid, 1 part of triethanolpropane trimethacrylate, 1 part of 1,6-hexanediol dimethacrylate, and 0.5 part of t-

dodecylmercaptan was added to the mixture at 70°C with stirring to perform a polymerization reaction. Thereafter, the system was neutralized with ammonia and adjusted to pH 8 to 8.5, followed by filtration through a 0.3 μ m filter to obtain polymeric fine particle C as an emulsion.

Polymeric fine particle D

Ion-exchanged water (100 parts) was placed in a reactor equipped with a dropping device, a thermometer, a water cooling type reflux condenser, and a stirrer. Potassium persulfate as a polymerization initiator (0.2 part) was added to the system with stirring in a nitrogen atmosphere at 70°C. A monomer solution was prepared by adding 0.05 part of sodium laurylsulfate, 15 parts of styrene, 15 parts of butyl methacrylate, and 0.02 part of t-dodecylmercaptan to 7 parts of ion-exchanged water. This monomer solution was added dropwise to the reactor at 70°C to perform a reaction. Thus a primary compound was prepared. A 10% ammonium persulfate solution (2 parts) was added to the primary compound. The mixture was stirred. A reaction solution composed of 30 parts of ion-exchanged water, 0.2 part of potassium laurylsulfate, 30 parts of styrene, 15 parts of butyl methacrylate, 1 part of dipentaerythritol hexamethacrylate, and 0.6 part of t-dodecylmercaptan was added to the mixture at 70°C with stirring to perform a polymerization reaction. Thereafter, the system was neutralized with ammonia and adjusted to pH 8 to 8.5, followed by filtration through a 0.3 μ m filter to obtain polymeric fine particle D as an emulsion.

Example A

Preparation of inks

In the following examples, water-soluble pigments 1 to 4 are water-soluble pigments prepared by oxidizing the surface of carbon black having a particle diameter of 10 to 300 nm to introduce a carbonyl-terminated group, a carboxyl-terminated group, a hydroxyl-terminated group and/or a sulfone-terminated group into the surface of the carbon black. The average particle diameter of the

water-soluble pigments was as indicated in parentheses (unit: nm).

The compounds of formula (I) used in Example A were compounds wherein T represents a hydrogen atom.

5 In the following description, water-soluble dye 1 is Direct Black 154, water soluble dye 2 Direct Yellow 132, water-soluble dye 3 Direct Blue 86, and water-soluble dye 4 Acid Red 52.

10 Into all the inks described below were added 0.1 to 1% by weight of Proxel XL-2 as a corrosion preventive for inks and 0.001 to 0.05% by weight of benzotriazole as a corrosion preventive for an ink jet head member.

	Example A1	Amount added (wt%)
	Water-soluble pigment 1 (105)	5.0
15	Compound A1 of formula (I)	8.0
	DEGmBE	2.0
	Polymeric fine particle A	3.0
	Glycerin	6.0
	1,5-Pentanediol	5.0
20	Triethanolamine	0.8
	Ion-exchanged water	Balance

Compound A1 of formula (I) is a compound of formula (I) wherein R represents a neopentyl group, n is 3, and m is 1.5.

	Example A2	
25	Water-soluble pigment 2 (85)	4.5
	Compound A2 of formula (I)	10.0
	Polymeric fine particle A	3.0
	Dipropylene glycol	5.0
	Surfynol 465	1.2
30	Triethanolamine	0.9
	Ion-exchanged water	Balance

Compound A2 of formula (I) is a compound of formula (I) wherein R represents a t-butyl group, n is 3, and m is 1.3.

	Example A3	
35	Water-soluble pigment 3 (90)	5.5
	Compound A3 of formula (I)	10.0
	Polymeric fine particle B	10.0

	Diethylene glycol	7.0
	Thiodiglycol	3.5
	1,6-Hexanediol	5.0
	Triethanolamine	1.0
5	Potassium hydroxide	0.1
	Ion-exchanged water	Balance

Compound A3 of formula (I) is a compound of formula (I) wherein R represents a 1,3-dimethylbutyl group, n is 3, and m is 1.5.

10 Example A4

	Water-soluble pigment 4 (80)	5.0
	Water-soluble dye 1	1.0
	Compound A4 of formula (I)	8.0
	TEGmBE	3.0
15	Polymeric fine particle C	1.0
	Diethylene glycol	3.0
	1,5-Pentanediol	2.0
	Dimethyl-2-imidazolidinone	2.0
	Sodium benzoate	0.1
20	Triethanolamine	0.7
	Ion-exchanged water	Balance

Compound A4 of formula (I) is a compound of formula (I) wherein R represents an isobutyl group, n is 3, and m is 0.5.

Example A5

25	Water-soluble pigment 1 (105)	3.0
	Water-soluble dye 1	1.0
	Compound A5 of formula (I)	7.0
	DEGmBE	2.0
	Polymeric fine particle D	1.0
30	Glycerin	14.0
	Triethanolamine	0.9
	Ion-exchanged water	Balance

Compound A5 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents an n-hexyl group, n is 4, and m is 2, with 50% by weight of a compound of formula (I), wherein R represents a 2-ethylhexyl group, n is 4, and m is 0.

Example A6

	Water-soluble dye 2	5.0
	Compound A6 of formula (I)	6.0
	TEGmBE	4.0
5	Glycerin	15.0
	Thiodiglycol	2.0
	1,5-Pentanediol	1.0
	Triethanolamine	0.9
	Ion-exchanged water	Balance

- 10 Compound A6 of formula (I) is a compound of formula (I) wherein R represents a 1,1-dimethylbutyl group, n is 4, and m is 1.

Example A7

	Water-soluble dye 3	5.0
15	Compound A7 of formula (I)	10.0
	DEGmBE	3.0
	Glycerin	5.0
	Trimethylolpropane	1.0
	Trimethylolethane	1.0
20	Surfynol 465	1.0
	Triethanolamine	0.5
	KOH	0.05
	Ion-exchanged water	Balance

- 25 Compound A7 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents a 1,3-dimethylbutyl group, n is 3, and m is 1, with 50% by weight of a compound of formula (I) wherein R represents a n-heptyl group, n is 3.5, and m is 1.

Example A8

30	Water-soluble dye 4	5.5
	Compound A8 of formula (I)	6.0
	Glycerin	5.0
	Diethylene glycol	5.0
	Tetrapropylene glycol	5.0
35	Triethanolamine	0.9
	KOH	0.1
	Ion-exchanged water	Balance

Compound A8 of formula (I) is a mixture of 50% by weight of a compound of formula (I) wherein R represents a neopentyl group, n is 1.0, and m is 0.3, with 30% by weight of a compound of formula (I) wherein R represents an n-pentyl group, n is 2.5, and m is 1.0, and 20% by weight of a compound of formula (I) wherein R represents an isopentyl group, n is 3.0, and m is 1.5.

Comparative Example A

In the following comparative examples, the term "water-soluble pigments" refers to a carbon black which has been dispersed with the aid of a styrene/acrylic random copolymer as a dispersant, and the average particle diameter thereof was as indicated in the parentheses (unit: nm).

Comparative Example 1

15	Water-soluble pigment 9 (90)	5.0
	Glycerin	10.0
	Dispersant	3.0
	Nonionic surfactant	1.0
	Ion-exchanged water	Balance

Comparative Example 2

20	Water-soluble dye (Food Black 2)	5.5
	DEGmME	7.0
	Diethylene glycol	10.0
	2-Pyrrolidone	5.0
25	Ion-exchanged water	Balance

Comparative Example 3

	Water-soluble pigment 11 (110)	5.5
	Water-soluble dye (Food Black 2)	2.5
	Diethylene glycol	10.0
30	Nonionic surfactant	1.0
	Ion-exchanged water	Balance

Print evaluation test

Characters were printed using the inks prepared in Examples A1 to A8 and Comparative Examples A1 to A3 by means of an ink jet printer MJ-930C (manufactured by Seiko Epson Corp.). Papers used for the evaluation were Conqueror, Favorit, Modo Copy, Rapid Copy, EPSON EPP, Xerox 4024, Xerox

10, Neenha Bond, Ricopy 6200, Yamayuri, and Xerox R papers that are plain papers commercially available in Europe, America, and Japan.

The prints thus obtained were evaluated for feathering according to the following criteria.

Assuming that 10 to 50 mg of a spherical ink droplet was spread in a circular form on the surface of paper, the radius of an circumscribed circle, r_2 , to the radius of an inscribed circle, r_1 , that is, r_2/r_1 , in the formed ink dot was determined. The results were evaluated according to the following criteria.

A: $r_2/r_1 \leq 2.0$

B: $2.0 < r_2/r_1 \leq 4.0$

C: $4.0 < r_2/r_1 \leq 6.0$

D: $6.0 < r_2/r_1$

The results of evaluation were as summarized in the following table.

	Example A								Comparative Example A		
	1	2	3	4	5	6	7	8	1	2	3
Conqueror	A	A	A	A	A	A	A	A	C	C	D
Favorit	A	A	A	A	A	A	A	A	D	D	D
Modo Copy	A	A	A	A	A	A	A	A	C	D	D
Rapid Copy	A	A	A	A	A	A	A	A	C	D	D
EPSON EPP	A	A	A	A	A	A	A	A	C	C	D
Xerox P	A	A	A	A	A	A	A	A	C	D	D
Xerox 4024	A	A	A	A	A	A	A	A	C	D	D
Xerox 10	A	A	A	A	A	A	A	A	B	D	D
Neenha Bond	A	A	A	A	A	A	A	A	C	D	D
Ricopy 6200	A	A	A	A	A	A	A	A	B	C	D
Yamayuri	A	A	A	A	A	A	A	A	D	D	D
Xerox R	A	A	A	A	A	A	A	A	C	D	D

Example B

In the following examples, water-soluble pigments 1 to 4 are water-soluble pigments prepared by oxidizing the surface of carbon black having a particle diameter of 10 to 300 nm to introduce a carbonyl-terminated group, a carboxyl-terminated group, a hydroxyl-terminated group

5 The compounds of formula (I) used in Example B were
compounds wherein T represents a hydrogen atom.

10 4 Acid Red 52.

15	Example B1	Amount added (wt%)
	Water-soluble pigment 1 (105)	5.0
	Compound B1 of formula (I)	8.0
	DEGmBE	2.0
	Polymeric fine particle A	3.0
20	Diethylene glycol	16.0
	2-Pyrrolidone	5.0
	Triethanolamine	0.8
	Ion-exchanged water	Balance

Example B2

35 The compound B2 of formula (I) is a compound of formula (I) wherein R represents an Ra-t-butyl group (Ra-(1,1-dimethyl)ethylene group), $n + n'$ is 3, and $m + m'$ is 1.3.

Example B3

	Water-soluble pigment 3 (90)	5.5
	Compound B3 of formula (I)	2.0
	Polymeric fine particle B	10.0
5	Diethylene glycol	7.0
	Thiodiglycol	3.5
	1,6-Hexanediol	5.0
	Triethanolamine	1.0
	Potassium hydroxide	0.1
10	Ion-exchanged water	Balance

The compound B3 of formula (I) is a compound of formula (I) where R represents an Ra-1,3-dimethylbutyl group (Ra-(1,3-dimethyl)butylene group), $n + n'$ is 3, and $m + m'$ is 1.5.

15 Example B4

	Water-soluble pigment 4 (80)	5.0
	Water-soluble dye 1	1.0
	Compound B4 of formula (I)	8.0
	TEGmBE	3.0
20	Polymeric fine particle C	1.0
	Diethylene glycol	3.0
	1,5-Pentanediol	2.0
	Dimethyl-2-imidazolidinone	2.0
	Sodium benzoate	0.1
25	Triethanolamine	0.7
	Ion-exchanged water	Balance

The Compound B4 of formula (I) is a compound of formula (I) wherein R represents an Ra-isobutyl group (a 1-methylpropenyl group), $n + n'$ is 3, and $m + m'$ is 0.5.

30 Example B5

	Water-soluble pigment 1 (105)	3.0
	Water-soluble dye 1	1.0
	Compound B5 of formula (I)	7.0
	DEGmBE	2.0
35	Polymeric fine particle D	1.0
	Glycerin	14.0
	Triethanolamine	0.9

Ion-exchanged water

Balance

The compound B5 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents an Ra-n-hexyl group (an Ra-n-hexylene group), $n + n'$ is 4, and $m + m'$ is 2, with 50% by weight of a compound of formula (I) wherein R represents an Ra-2-ethylhexyl group (an Ra-2-ethylhexylene group), $n + n'$ is 4, and $m + m'$ is 0.

Example B6

	Water-soluble dye 2	5.0
10	Compound B6 of formula (I)	6.0
	TEGmBE	4.0
	Glycerin	15.0
	Thiodiglycol	2.0
	1,5-Pentanediol	1.0
15	Triethanolamine	0.9
	Ion-exchanged water	Balance

The compound B6 of formula (I) is a compound of formula (I) wherein R represents an Ra-1,1-dimethylbutyl group (an Ra-1,1-dimethylbutylene group), $n + n'$ is 4, and $m + m'$ is 1.

Example B7

	Water-soluble dye 3	5.0
	Compound B7 of formula (I)	10.0
	DEGmBE	3.0
25	Glycerin	5.0
	Trimethylolpropane	1.0
	Trimethylolethane	1.0
	Surfynol 465	1.0
	Triethanolamine	0.5
30	KOH	0.05
	Ion-exchanged water	Balance

The compound B7 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents an Ra-1,3-dimethylbutyl group (an Ra-1,3-dimethylbutyl group), $n + n'$ is 3, and $m + m'$ is 1, with 50% by weight of a compound of formula (I) wherein R represents an Ra-n-heptyl group (an Ra-n-heptylene group), $n + n'$ is 3.5, and $m + m'$

is 1.

Example B8

	Water-soluble dye 4	5.5
	Compound B8 of formula (I)	6.0
5	Glycerin	5.0
	Diethylene glycol	5.0
	Tetrapropylene glycol	5.0
	Triethanolamine	0.9
	KOH	0.1
10	Ion-exchanged water	Balance

The compound B8 of formula (I) is a mixture of 50% by weight of a compound of formula (I) wherein R represents an Ra-neopentyl group (an Ra-(2,2-dimethyl)propylene group), $n + n'$ is 1.0, and $m + m'$ is 0.3, with 30% by weight of a compound of formula (I), wherein R represents an Ra-n-pentyl group (an Ra-n-pentylene group), $n + n'$ is 2.5, and $m + m'$ is 1.0, and 20% by weight of a compound of formula (I) wherein R represents an Ra-isopentyl group (an Ra-(1-methyl)butylene group), $n + n'$ is 3.0, and $m + m'$ is 1.5.

20 Print evaluation test

In the same manner as in Examples A1 to A8 and Comparative Examples B1 to B3, the inks of Examples B1 to B8 were subjected to a print evaluation test, and the prints were evaluated for feathering. The results were as summarized in the following table.

	Example B							
	1	2	3	4	5	6	7	8
Conqueror	A	A	A	A	A	A	A	A
Favorit	A	A	A	A	A	A	A	A
Modo Copy	A	A	A	A	A	A	A	A
Rapid Copy	A	A	A	A	A	A	A	A
EPSON EPP	A	A	A	A	A	A	A	A
Xerox P	A	A	A	A	A	A	A	A
Xerox 4024	A	A	A	A	A	A	A	A
Xerox 10	A	A	A	A	A	A	A	A
Neenha Bond	A	A	A	A	A	A	A	A
Ricopy 6200	A	A	A	A	A	A	A	A
Yamayuri	A	A	A	A	A	A	A	A
Xerox R	A	A	A	A	A	A	A	A

Example C

Pigments 1 to 4 below were used in the following examples.

5 Pigment 1

A styrene/acrylic acid copolymer (weight average molecular weight 25000, acid value 200) (4 parts), 2.7 parts of triethanolamine, 0.4 part of isopropyl alcohol, and 72.9 parts of ion-exchanged water were completely dissolved in one another with heating at 70°C. Carbon black MA-100 (manufactured by Mitsubishi Kasei Corp.) (20 parts) was added to the solution. After premixing, dispersion was carried out by means of Eiger Mill (manufactured by Eiger Japan) to an average pigment particle diameter of 100 nm (percentage beads packing 70%, media diameter 0.7 mm) to obtain pigment 1 as a pigment dispersion. For pigment 1, the average diameter of dispersed particles was 105 nm.

Pigment 2

A dispersion of pigment 2 was prepared in the same manner as used in the preparation of the dispersion of Pigment 1. For pigment 2, the average diameter of dispersed particles was 85 nm.

Pigments 3 and 4

Pigments 3 and 4 were prepared by oxidizing (nitrating) the surface of carbon black to introduce a carbonyl-terminated group and/or a carboxyl-terminated group into the surface of the carbon black. Pigments 3 and 4 respectively had an average diameter of dispersed particles of 90 nm and an average diameter of dispersed particles of 80 nm.

In the following description, dye 1 is Direct Black 154, dye 2 Direct Yellow 132, dye 3 Direct Blue 86, and dye 4 Acid Red 52.

Example C1	Amount added (wt%)
Pigment 1	5.0
35 Compound C1 of formula (I)	15.0
DEGmBE	2.0
Glycerin	6.0

The compound C1 of formula (I) is a compound of formula
5 (I) wherein R represents a neopentyl group, n is 1.0, m is
1.5, and T represents SO₃M wherein M represents sodium.

	Pigment 2	4.5
	Compound C2 of formula (I)	10.0
10	Dipropylene glycol	5.0
	Surfynol 465	1.2
	Triethanolamine	0.9
	Ion-exchanged water	Balance

Example C3

The compound C3 of formula (I) is a compound of formula (I) wherein R represents a 1,3-dimethylbutyl group, n is 0, m is 4.5, and T represents SO₃M wherein M represents H.

30	Pigment 4	5.0
	Dye 1	1.0
	Compound C4 of formula (I)	8.0
	TEGmBE	3.0
	Diethylene glycol	3.0
35	1,5-Pentanediol	2.0
	Dimethyl-2-imidazolidinone	2.0
	Sodium benzoate	0.1

Triethanolamine	0.7
Ion-exchanged water	Balance

The compound C4 of formula (I) is a compound of formula (I) wherein R represents an isobutyl group, n is 3.0, m is 1.0, and T represents SO_3M wherein M represents ammonia.

Example C5

Pigment 1	3.0
Dye 1	1.0
Compound C5 of formula (I)	7.0
DEGmBE	2.0
Glycerin	14.0
Triethanolamine	0.9
Ion-exchanged water	Balance

The compound C5 of formula (I) is a mixture of 50% by weight of a compound of formula (I) wherein R represents an n-hexyl group, n is 4.0, m is 1.0, and T represents SO_3M wherein M represents potassium, with 50% by weight of a compound of formula (I) wherein R represents a 2-ethylhexyl group, n is 2.0, m is 1.0, and T represents SO_3M wherein M represents potassium.

Example C6

Dye 2	5.0
Compound C6 of formula (I)	6.0
TEGmBE	4.0
Glycerin	15.0
Thiodiglycol	2.0
1,5-Pentanediol	1.0
Triethanolamine	0.9
Ion-exchanged water	Balance

The compound C4 of formula (I) is a compound of formula (I) wherein R represents a 1,1-dimethylbutyl group, n is 7.0, m is 1.0, and T represents SO_3M wherein M represents lithium.

Example C7

Dye 3	5.0
Compound C7 of formula (I)	10.0
DEGmBE	3.0
Glycerin	5.0

	Trimethylolpropane	1.0
	Trimethylolethane	1.0
	Surfynol 465	1.0
	Triethanolamine	0.5
5	KOH	0.05
	Ion-exchanged water	Balance

The compound C4 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents an n-butyl group, n is 9.0, m is 1.0, and T represents SO₃M wherein M represents sodium, with 50% by weight of a compound of formula (I) wherein R represents an n-heptyl group, n is 3.5, m is 2.0, and T represents SO₃M wherein M represents potassium).

Example C8

15	Dye 4	5.5
	Compound C8 of formula (I)	6.0
	Glycerin	5.0
	Diethylene glycol	5.0
	Tetrapropylene glycol	5.0
20	Triethanolamine	0.9
	KOH	0.1
	Ion-exchanged water	Balance

The compound C8 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents a neopentyl group, n is 0, m is 1.0, and T represents SO₃M wherein M represents potassium, with 30% by weight of a compound of formula (I), wherein R represents an n-pentyl group, n is 2.5, m is 1.0, and T represents SO₃M wherein M represents ammonia, and 20% by weight of a compound of formula (I) wherein R represents an isopentyl group, n is 3.0, m is 1.5, and T represents SO₃M wherein M represents sodium.

Comparative Example C

Comparative Example C1

	Pigment 1	5.0
35	Glycerin	10.0
	Dispersant	3.0
	Nonionic surfactant	1.0

Ion-exchanged water

Balance

Nonionic surfactant: Noigen EA-160 manufactured by
Dai-ichi Kogyo Seiyaku Co., Ltd.

Comparative Example C2

5	Dye 2	5.5
	DEGmME	7.0
	Diethylene glycol	10.0
	2-Pyrrolidone	5.0
	Ion-exchanged water	Balance

10 Comparative Example C3

Pigment 3	5.5
Dye 1	2.5
Diethylene glycol	10.0
Nonionic surfactant	1.0

15 Ion-exchanged water Balance

Nonionic surfactant: Evan 450 manufactured by Dai-ichi
Kogyo Seiyaku Co., Ltd.

Print evaluation test

20 In the same manner as in Examples A1 to A8 and
Comparative Examples B1 to B3, the inks of Examples C1 to
C8 and Comparative Examples C1 to C3 were subjected to a print
evaluation test, and the prints were evaluated for feathering.
The results were as summarized in the following table.

	Example C								Comparative Example C		
	1	2	3	4	5	6	7	8	1	2	3
Conqueror	A	A	A	A	A	A	A	A	C	C	C
Favorit	A	A	A	A	A	A	A	A	D	D	D
Modo Copy	A	A	A	A	A	A	A	A	C	D	D
Rapid Copy	A	A	A	A	A	A	A	A	D	D	D
EPSON EPP	A	A	A	A	A	A	A	A	C	C	D
Xerox P	A	A	A	A	A	A	A	A	C	C	D
Xerox 4024	A	A	A	A	A	A	A	A	D	D	D
Xerox 10	A	A	A	A	A	A	A	A	C	D	D
Neenha Bond	A	A	A	A	A	A	A	A	C	D	D
Ricopy 6200	A	A	A	A	A	A	A	A	D	C	D
Yamayuri	A	A	A	A	A	A	A	A	D	D	D
Xerox R	A	A	A	A	A	A	A	A	D	D	D

Storage stability test

The inks prepared in Examples C1 to C8 were placed in sample bottles made of glass. The bottles were hermetically sealed, and allowed to stand at 60°C for one week. At the end of this storage period, the inks were inspected for a change in occurrence sediments and a change in property values (viscosity and surface tension) from the inks before the standing. As a result, for all the inks, substantially no change occurred in occurrence of sediments and in property values.

Example DPigment dispersion

Pigment dispersions used in Examples D1 to D4 were prepared as follows. A styrene/acrylic acid copolymer (weight average molecular weight 25000, acid value 200) (4 parts), 2.7 parts of triethanolamine, 0.4 part of isopropyl alcohol, and 72.9 parts of ion-exchanged water were completely dissolved in one another with heating at 70°C. Carbon black MA-100 (manufactured by Mitsubishi Kasei Corp.) (20 parts) was added to the solution. After premixing, dispersion was carried out by means of Eiger Mill (manufactured by Eiger Japan) to an average pigment particle diameter of 100 nm (percentage beads packing 70%, media diameter 0.7 mm) to obtain a pigment as a pigment dispersion. For the pigment thus obtained, the average diameter of dispersed particles was 105 nm.

Water-soluble pigment

The water-soluble pigment used in Example D5 is a water-soluble pigment prepared by oxidizing (nitrating) the surface of carbon black to introduce a carbonyl-terminated group and/or a carboxyl-terminated group into the surface. The average diameter of dispersed particles was 120 nm.

The compound of formula (I) used in Example D is a mixture of compounds of formula (I) wherein EO represents $-\text{CH}_2\text{CH}_2\text{O}-$, PO represents $-\text{CH}(\text{CH}_3)-\text{CH}_2\text{O}-$, and T represents a hydrogen atom, R, EO, PO, and T being attached to one another in that order to represent formula $\text{R}-(\text{EO})_n-(\text{PO})_m-\text{T}$.

Example D1		Amount added (wt%)
	Pigment dispersion 1	5.0
	Compound D1 of formula (I)	8.0
	DEGmBE	2.0
5	Glycerin	6.0
	1,5-Pentanediol	5.0
	Triethanolamine	0.8
	Ion-exchanged water	Balance

The compound D1 of formula (I) is a compound of formula
 10 (I) wherein R represents a neopentyl group, n is 3, and m is 1.5.

Example D2		
	Pigment dispersion	4.5
	Compound D2 of formula (I)	10.0
15	Dipropylene glycol	5.0
	Surfynol 465	1.2
	Triethanolamine	0.9
	Ion-exchanged water	Balance

The compound D2 of formula (I) is a compound of formula
 20 (I) wherein R represents a t-butyl group, n is 3, and m is 1.3.

Example D3		
	Pigment dispersion	5.5
	Compound D3 of formula (I)	10.0
25	Diethylene glycol	7.0
	Thiodiglycol	3.5
	1,6-Hexanediol	5.0
	Triethanolamine	1.0
	Potassium hydroxide	0.1
30	Ion-exchanged water	Balance

The compound D3 of formula (I) is a compound of formula
 (I) wherein R represents a 1,3-dimethylbutyl group, n is 3,
 and m is 1.5.

Example D4		
35	Pigment dispersion	5.0
	Compound D4 of formula (I)	8.0
	TEGmBE	3.0

	Diethylene glycol	3.0
	1,5-Pentanediol	2.0
	Dimethyl-2-imidazolidinone	2.0
	Sodium benzoate	0.1
5	Triethanolamine	0.7
	Ion-exchanged water	Balance

The compound D4 of formula (I) is a compound of formula (I) wherein R represents an isobutyl group, n is 3, and m is 0.5.

10	Example D5	
	Water-soluble pigment	3.0
	Compound D5 of formula (I)	7.0
	DEGmBE	2.0
	Glycerin	14.0
15	Triethanolamine	0.9
	Ion-exchanged water	Balance

The compound D5 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents an n-hexyl group, n is 4, and m is 2, with 50% by weight of a compound of formula (I) wherein R represents a 2-ethylhexyl group, n is 4, and m is 0.

Evaluation test

The inks prepared in Examples D1 to D5 were printed on Conqueror, Favorit, Modo Copy, Rapid Copy, EPSON EPP, Xerox 25 4024, Xerox 10, Neenha Bond, Ricopy 6200, Yamayuri, and Xerox R papers. The prints were inspected for the sharpness of edges and the rapid dryness of printed images and evaluated according to the following criteria. The evaluation results were expressed in terms of the average value on data for the 30 various papers.

Item 1. Sharpness of edge

A: Most of printed patterns were free from feathering and having sharp edges independently of types of papers

B: For some printed patterns, somewhat unsharped edges 35 having no practical problem were found with the difference in edge sharpness being small among types of papers.

C: For all the types or some types of papers, the printed

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patterns suffered from unsharped edges and image burring and were unsuitable for practical use.

Item 2. Rapid dryness

A: 30 sec after printing, touching of the prints by a finger did not cause smearing.

B: 30 sec after printing, touching of the prints by a finger caused smearing.

The results were as summarized in the following table.

10	<u>Example No.</u>	<u>D1</u>	<u>D2</u>	<u>D3</u>	<u>D4</u>	<u>D5</u>
	Evaluation 1	B	A	B	A	B
	<u>Evaluation 2</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>A</u>

Example E

15 In the following examples, water-soluble pigments 1 to 4 are water-soluble pigments prepared by oxidizing the surface of carbon black having a particle diameter of 10 to 300 nm to introduce a carbonyl-terminated group, a carboxyl-terminated group, a hydroxyl-terminated group and/or a sulfone-terminated group into the surface of the carbon black. The average particle diameter of the water-soluble pigments was as indicated in parentheses (unit: nm).

25 The compound of formula (I) used in Example E is a mixture of a compound of formula (I), wherein T represents a hydrogen atom, R, EO, PO, and T being attached to one another in that order to represent formula $R-(EO)_n1-(PO)_m1-T$, with a compound of formula (I) wherein T represents a hydrogen atom, R, PO, EO, and T being attached to one another in that order to represent formula $R-(PO)_m2-(EO)_n2-T$. The former compound will be hereinafter referred to as "compound (I-1)," while the latter compound will be hereinafter referred to as "compound (I-2)."

35 In the following description, water-soluble dye 1 is Direct Black 154, water-soluble dye 2 Direct Yellow 132, water-soluble dye 3 Direct Blue 86, and water-soluble dye 4 Acid Red 52.

Into all the inks described below were added 0.1 to 1% by weight of Proxel XL-2 as a corrosion preventive for inks and 0.001 to 0.05% by weight of benzotriazole as a corrosion preventive for an ink jet head member.

5	Example E1	Amount added (wt%)
	Water-soluble pigment 1 (105)	5.0
	Compound E1 of formula (I-1)	1.0
	Compound E1 of formula (I-2)	1.0
	DEGmBE	3.0
10	Polymeric fine particle A	3.0
	Diethylene glycol	16.0
	2-Pyrrolidone	5.0
	Ion-exchanged water	Balance

The compound E1 of formula (I-1) is a compound of formula (I) wherein R1 represents a neopentyl group, n1 is 3, and m1 is 1.5. The compound E1 of formula (I-2) is a compound of formula (I) wherein R represents a hexyl group, n2 is 5, and m2 is 2.

	Example E2	
20	Water-soluble pigment 2 (85)	4.5
	Compound E2 of formula (I-1)	2.0
	Compound E2 of formula (I-2)	1.0
	Polymeric fine particle A	3.0
	Dipropylene glycol	5.0
25	Surfynol 465	1.2
	Ion-exchanged water	Balance

The compound E2 of formula (I-1) is a compound of formula (I) wherein R1 represents a t-butyl group, n1 is 3, and m1 is 1.3. The compound E2 of formula (I-2) is a compound of formula (I) wherein R represents an iso-butyl group, n2 is 3, and m2 is 1.

	Example E3	
	Water-soluble pigment 3 (90)	5.5
	Compound E3 of formula (I-1)	1.0
35	Compound E3 of formula (I-2)	2.0
	Polymeric fine particle B	10.0
	Diethylene glycol	7.0

Thiodiglycol	3.5
1,6-Hexanediol	5.0
Potassium hydroxide	0.1
Ion-exchanged water	Balance

- 5 The compound E3 of formula (I-1) and the compound E3 of formula (I-2) each are a compound of formula (I) wherein R represents a 1,3-dimethylbutyl group, $n_1 + n_2$ is 3, and $m_1 + m_2$ is 1.5.

Example E4

10	Water-soluble pigment 4 (80)	5.0
	Water-soluble dye 1	1.0
	Compound E4 of formula (I-1)	4.0
	Compound E4 of formula (I-2)	4.0
	TEGmBE	3.0
15	Polymeric fine particle C	1.0
	Diethylene glycol	3.0
	1,5-Pentanediol	2.0
	Dimethyl-2-imidazolidinone	2.0
	Sodium benzoate	0.1
20	Triethanolamine	0.7
	Ion-exchanged water	Balance

- 25 The compound E4 of formula (I-1) and the compound E4 of formula (I-2) each are a compound of formula (I) wherein R represents an isobutyl group, $n_1 + n_2$ is 3, and $m_1 + m_2$ is 0.5.

Example E5

	Water-soluble pigment 1 (105)	3.0
	Water-soluble dye 1	1.0
	Compound E5 of formula (I-1)	4.0
30	Compound E5 of formula (I-2)	3.0
	DEGmBE	2.0
	Polymeric fine particle D	1.0
	Glycerin	10.0
	Diethylene glycol	4.0
35	Ion-exchanged water	Balance

- The compound E5 of formula (I-1) and the compound E5 of formula (I-2) each are a mixture of 50% by weight of a

compound of formula (I), wherein R represents an n-hexyl group, $n_1 + n_2$ is 4, and $m_1 + m_2$ is 2, with 50% by weight of a compound of formula (I) wherein R represents a 2-ethylhexyl group, $n_1 + n_2$ is 4, and $m_1 + m_2$ is 0.

5 Example E6

	Water-soluble dye 2	5.0
	Compound E6 of formula (I-1)	5.0
	Compound E6 of formula (I-2)	1.0
	TEGmBE	4.0
10	Glycerin	10.0
	Thiodiglycol	2.0
	1,5-Pentanediol	1.0
	Ion-exchanged water	Balance

15 The compound E6 of formula (I-1) and the compound E6 of formula (I-2) each are a compound of formula (I) wherein R represents a 1,1-dimethylbutyl group, $n_1 + n_2$ is 4, and $m_1 + m_2$ is 1.

 Example E7

	Water-soluble dye 3	5.0
20	Compound E7 of formula (I-1)	8.0
	Compound E7 of formula (I-2)	2.0
	DEGmBE	3.0
	Glycerin	5.0
	Trimethylolpropane	1.0
25	Trimethylolethane	1.0
	Surfynol 465	1.0
	KOH	0.05
	Ion-exchanged water	Balance

30 The compound E7 of formula (I-1) and the compound E7 of formula (I-2) each are a mixture of 50% by weight of a compound of formula (I), wherein R represents a 1,3-dimethylbutyl group, $n_1 + n_2$ is 3, and $m_1 + m_2$ is 1, with 50% by weight of a compound of formula (I) wherein R represents an n-heptyl group, $n_1 + n_2$ is 3.5, and $m_1 + m_2$ is 1.

35 Example E8

	Water-soluble dye 4	5.5
	Compound E8 of formula (I-1)	3.0

The compound E8 of formula (I-1) and the compound E8 of formula (I-2) each are a mixture of 50% by weight of a compound of formula (I) wherein R represents a neopentyl group, $n_1 + n_2$ is 1.0, and $m_1 + m_2$ is 0.3, with 30% by weight of a compound of formula (I) wherein R represents an n-pentyl group, $n_1 + n_2$ is 2.5, and $m_1 + m_2$ is 1.0, and 20% by weight of a compound of formula (I) wherein R represents an isopentyl group, $n_1 + n_2$ is 3.0, $m_1 + m_2$ is 1.5.

15 In the same manner as in Examples A1 to A8 and Comparative Examples B1 to B3, the inks of Examples E1 to E8 were subjected to a print evaluation test, and the prints were evaluated for feathering. The results were as summarized in the following table.

20

In the following examples, water-soluble pigments 1 to 4 are water-soluble pigments prepared by oxidizing the surface of a carbon black or an organic pigment having a particle diameter of 10 to 300 nm to introduce a

carbonyl-terminated group, a carboxyl-terminated group, a hydroxyl-terminated group and/or a sulfone-terminated group into the surface of the carbon black or organic pigment. The average particle diameter of the water-soluble pigments was as indicated in parentheses (unit: nm).

In the following description, water-soluble dye 1 is Direct Black 154, water-soluble dye 2 Direct Yellow 132, water-soluble dye 3 Direct Blue 86, and water-soluble dye 4 Acid Red 52.

10

Example F1	Amount added (wt%)
Water-soluble pigment 1 (105)	5.0
Compound F1 of formula (I)	8.0
DEGmBE	2.0
Glycerin	6.0
1,5-Pentanediol	5.0
Triethanolamine	0.8
Ion-exchanged water	Balance

15

Compound F1 of formula (I) is a compound of formula (I) wherein R represents a (2-tetrahydrofuran)methyloxy group, m is 1.5, and n is 3. Water-soluble pigment 1 is a carbon black which has been surface treated to attach mainly carboxyl groups onto the surface of the carbon black.

20

Example F2

Water-soluble pigment 2 (85)	4.5
Compound F2 of formula (I)	10.0
Dipropylene glycol	5.0
Surfynol 465	1.2
Triethanolamine	0.9
Ion-exchanged water	Balance

25

30

Compound F2 of formula (I) is a compound of formula (I) wherein R represents a cyclohexyloxy group, m is 1.3, and n is 6. Water-soluble pigment 2 is a carbon black which has been surface treated to attach mainly sodium sulfonate groups onto the surface of the carbon black.

35

Example F3

Water-soluble pigment 3 (90)	5.5
------------------------------	-----

	Compound F3 of formula (I)	10.0
	Diethylene glycol	7.0
	Thiodiglycol	3.5
	1,6-Hexanediol	5.0
5	Triethanolamine	1.0
	Potassium hydroxide	0.1
	Ion-exchanged water	Balance

Compound F3 of formula (I) is a mixture of 80% by weight of a compound of formula (I), wherein R represents a benzyloxy group, m is 1.5, and n is 3, with 20% by weight of a compound of formula (I), wherein R represents an α -ethylbenzyloxy group, m is 1.5, and n is 6. Water-soluble pigment 3 is a pigment prepared by surface treating quinacridone to attach mainly sulfonic acid groups onto the surface of quinacridone.

15 Example F4

	Water-soluble pigment 4 (80)	5.0
	Water-soluble dye 1	1.0
	Compound F4 of formula (I)	8.0
	TEGmBE	3.0
20	Diethylene glycol	3.0
	1,5-Pentanediol	2.0
	Dimethyl-2-imidazolidinone	2.0
	Sodium benzoate	0.1
	Triethanolamine	0.7
25	Ion-exchanged water	Balance

Compound F4 of formula (I) is a compound of formula (I) wherein R represents a cyclohexylmethyloxy group, m is 0.5, and n is 5. Water-soluble pigment 4 is a pigment prepared by surface treating phthalocyanine to attach mainly sulfonic acid groups onto the surface of phthalocyanine.

30 Example F5

	Water-soluble pigment 1 (105)	3.0
	Water-soluble dye 1	1.0
	Compound F5 of formula (I)	7.0
35	DEGmBE	2.0
	Glycerin	14.0
	Triethanolamine	0.9

Ion-exchanged water

Balance

Compound F5 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents an α -naphthyloxy group, m is 2, and n is 10, with 50% by weight of a compound of formula (I) wherein R represents a cycloheptyloxy group, m is 0, and n is 4.

Example F6

	Water-soluble dye 2	5.0
	Compound F6 of formula (I)	6.0
10	TEGmBE	4.0
	Glycerin	15.0
	Thiodiglycol	2.0
	1,5-Pentanediol	1.0
	Triethanolamine	0.9
15	Ion-exchanged water	Balance

Compound F6 of formula (I) is a compound of formula (I) wherein R represents a cyclopentyloxy group, m is 1, and n is 7.

Example F7

20	Water-soluble dye 3	5.0
	Compound F7 of formula (I)	10.0
	DEGmBE	3.0
	Glycerin	5.0
	Trimethylolpropane	1.0
25	Trimethylolethane	1.0
	Surfynol 465	1.0
	Triethanolamine	0.5
	KOH	0.05
	Ion-exchanged water	Balance

Compound F7 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents a p-methylbenzyloxy group, m is 1, and n is 9, with 50% by weight of a compound of formula (I) wherein R represents a o-methylbenzyloxy group, m is 1, and n is 5.5.

35 Example F8

	Water-soluble dye 4	5.5
	Compound F8 of formula (I)	6.0

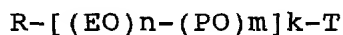
	1,2-Hexanediol	1.5
	Glycerin	5.0
	Diethylene glycol	5.0
	Tetrapropylene glycol	5.0
5	Triethanolamine	0.9
	KOH	0.1
	Ion-exchanged water	Balance

- Compound F8 of formula (I) is a mixture of 50% by weight of a compound of formula (I), wherein R represents a 2-methylphenyl-1-oxy group, m is 0.3, and n is 6, with 30% by weight of a compound of formula (I), wherein R represents an 4-t-butylphenyl-1-oxy group, m is 1, and n is 7, and 20% by weight of a compound of formula (I) wherein R represents a 4-t-butylphenylmethoxy group, m is 1.5, and n is 4.5.
- 15 The results of evaluation were as summarized in the following table.

	Example F							
	1	2	3	4	5	6	7	8
Conqueror	A	A	A	A	A	A	A	A
Favorit	A	A	A	A	A	A	A	A
Modo Copy	A	A	A	A	A	A	A	A
Rapid Copy	A	A	A	A	A	A	A	A
EPSON EPP	A	A	A	A	A	A	A	A
Xerox P	A	A	A	A	A	A	A	A
Xerox 4024	A	A	A	A	A	A	A	A
Xerox 10	A	A	A	A	A	A	A	A
Neenha Bond	A	A	A	A	A	A	A	A
Ricopy 6200	A	A	A	A	A	A	A	A
Yamayuri	A	A	A	A	A	A	A	A
Xerox R	A	A	A	A	A	A	A	A

What is claimed is:

1. An ink for ink jet recording, comprising at least a water-soluble colorant, a water-soluble organic solvent, water, and a mixture of two or more compounds represented by formula (I):



wherein

EO represents an ethyleneoxy group;

PO represents a propyleneoxy group;

T represents an OH group or SO_3M wherein M represents a hydrogen atom, an alkali metal, an inorganic base, or an organic amine;

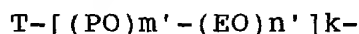
m and n are each an integer;

k is a natural number of not less than 1; and

R represents

a C_aH_{2a-k-1} group where "a" represents natural number of 4 to 10,

an $Ra-C_aH_{2a-k-2}$ group where "a" represents natural number of 4 to 10 and Ra represents a group represented by the following formula:



wherein

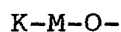
EO, PO, T and k each are as defined above; and

n' and m' are respectively n and m,

EO and PO being arranged, regardless of order in the parentheses, randomly or as blocks joined together,

n or n + n' being 1 to 10 with m or m + m' being 0 to 5 when n and m and n' and m' are expressed in terms of the average value for the mixture of compounds represented by formula (I) contained in the ink, or

a group represented by the following formula:



wherein K represents a saturated or unsaturated aromatic ring having 4 to 15 carbon atoms or a saturated or unsaturated aliphatic ring having 4 to 15 carbon atoms, M represents a bond or an alkylene group having 1 to 12 carbon atoms, and O represents an oxygen atom.

2. The ink according to claim 1, wherein the compounds, represented by formula (I), constituting the mixture each are such that R represents a C_aH_{2a-k-1} group and T represents a hydrogen atom.

3. The ink according to claim 1, wherein the compounds, represented by formula (I), constituting the mixture each are such that R represents an $Ra-C_aH_{2a-k-2}$ group and T represents a hydrogen atom.

4. The ink according to claim 1, wherein the compounds, represented by formula (I), constituting the mixture each are such that R represents a C_aH_{2a-k-1} group and T represents SO_3M .

5. The ink according to claim 1, wherein the compounds, represented by formula (I), constituting the mixture each are such that R represents a C_aH_{2a-k-1} group, EO represents $-CH_2CH_2O-$, PO represents $-CH(CH_3)-CH_2O-$, and T represents a hydrogen atom, R, EO, PO, and T being attached to one another in that order to represent formula $R-(EO)_n-(PO)_m-T$.

6. The ink according to claim 1, wherein the mixture of compounds represented by formula (I) is composed of:

a compound represented by formula (I) wherein R represents a C_aH_{2a-k-1} group and T represents a hydrogen atom, R, EO, PO, and T being attached to one another in that order to represent formula $R-(EO)_n-(PO)_m-T$; and

a compound represented by formula (I) wherein R represents a C_aH_{2a-k-1} group and T represents a hydrogen atom, R, EO, PO, and T being attached to one another in that order to represent formula $R-(PO)_m-(EO)_n-T$.

7. The ink according to claim 1, wherein n and m in the mixture of compounds represented by formula (I) satisfy $n/m \geq 0.5$.

8. The ink according to claim 1, wherein the compound represented by formula (I) has an average molecular weight of not more than 2000.

9. The ink according to claim 1, wherein the mixture of compounds represented by formula (I) is composed of:

a compound represented by formula (I) wherein R

represents a butyl, pentyl, hexyl, heptyl, octyl, nonyl, or decyl group; and

a compound represented by formula (I) wherein R represents a butyl, pentyl, hexyl, heptyl, octyl, nonyl, or decyl group.

10. The ink according to claim 1, wherein R represents a straight-chain or branched C_aH_{2a-k-1} group.

11. The ink according to claim 1, wherein the compounds, represented by formula (I), constituting the mixture each are such that R represents the group K-M-O- and T represents a hydrogen atom.

12. The ink according to claim 11, wherein K represents a saturated or unsaturated aromatic ring having 4 to 15 carbon atoms or a saturated or unsaturated aliphatic ring having 4 to 15 carbon atoms, M represents a bond or an alkylene group having 1 to 12 carbon atoms, and O represents an oxygen atom.

13. The ink according to claim 1, which further comprises 0 to 10% by weight of (di)propylene glycol monobutyl ether.

14. The ink according to claim 13, wherein the weight ratio of the compound represented by formula (I) to (di)propylene glycol monobutyl ether is 1 : 0 to 1 : 10.

15. The ink according to claim 1, which further comprises 0 to 5% by weight of an acetylene glycol surfactant.

16. The ink according to claim 15, wherein the weight ratio of the compound represented by formula (I) to the acetylene glycol surfactant is 1 : 0 to 1 : 3.

17. The ink according to claim 1, which further comprises 0 to 20% by weight of di(tri)ethylene glycol monobutyl ether.

18. The ink according to claim 17, wherein the weight ratio of the compound represented by formula (I) to di(tri)ethylene glycol monobutyl ether is 1 : 0 to 1 : 10.

19. The ink according to claim 1, wherein the water-soluble colorant is a water-soluble dye and/or a water-soluble pigment dispersible in water.

20. An ink jet recording method comprising the steps

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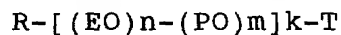
of: ejecting a droplet of an ink; and depositing the droplet onto a recording medium to perform printing, wherein the ink is one according to claim 1.

21. A recorded medium recorded by the ink jet recording method according to claim 20.

ABSTRACT

An ink is provided which can realize good images on various recording media, especially plain papers.

- 5 The ink comprises at least a water-soluble colorant, a water-soluble organic solvent, water, and a mixture of two or more compounds represented by formula (I):



wherein

- 10 EO represents an ethyleneoxy group;
 PO represents a propyleneoxy group;
 T represents an OH group or SO_3M wherein M represents a hydrogen atom, an alkali metal, an inorganic base, or an organic amine;
- 15 m and n are each an integer;
 k is a natural number of not less than 1; and
 R represents an alkyl or cyclic group.